Physikalisches Institut
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Masterarbeit

Integrated diamond photonics for long wavelength infrared (LWIR) applications

The aim of this project is to extend the wavelength regime of integrated optical circuits from the visible and near IR to the LWIR regime for sensing applications in the fingerprint region of many molecules. The advantage of integrated photonic circuits is the combination of strong light confinement in nanoscale structures with low propagation loss and the possibility to fabricate complex optical systems on a microchip. Established fabrication techniques allow for easy scalability and waferscale processing. Integrated optical systems enable on-chip metrology applications with high sensitivity and reproducibility.

For LWIR applications a material system is required where the waveguide and substrate materials are not absorbing and offer a high enough index contrast to maintain well light-guiding properties. Therefore, we work with diamond on aluminum nitrite, as well as freestanding diamond and silicon structures. Diamond in particular provides outstanding properties, like a very large transparency window, chemical stability, high thermal conductivity and a large Young's modulus. This enables optical and optomechanical devices that are operable even in harsh environments. Silicon on the other hand offers very low optical losses in combination with established fabrication methods and commercially available wafers. Therefore it is ideal as a reference material for future diamond LWIR devices.

This Master project includes the design and fabrication of integrated photonic circuits using nanofabrication and imaging techniques (e-beam lithography, dry and wet etching, material deposition, SEM, AFM), performing simulations to determine suitable geometrical parameters and optical characterization of fabricated devices with fiber-optical methods.

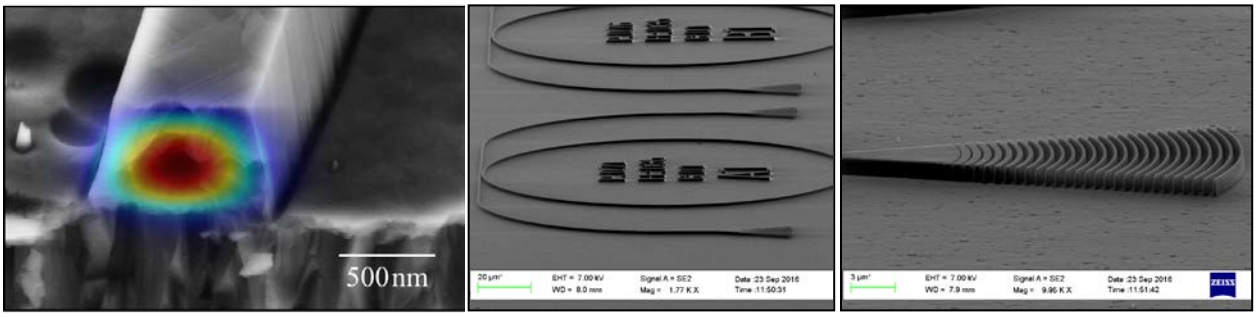

Figure 1: a) SEM micrograph of a cross section of a diamond on AlN waveguide with an overlay of the simulated field of a guided mode. b) Overview of ring resonators coupled to bus waveguides that are terminated by grating couplers. c) Zoom in on a grating coupler used for out-of-plane coupling of light to and from the waveguide.

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